According to several authors, the dominant cause for the decline leading to the proposed protection is the degradation of suitable habitat conditions during the freshwater and estuarine portions of the salmon life history (NRC, 1996). Many factors, scientific, institutional, political have contributed to the loss of habitats and populations which is pushing salmon toward extinction.

Stemming and reversing this trend will require that we question the most basic assumptions that guide management of this resource. We will need to examine our institutions, our motives, our view of the problem and the possible solutions, with an eye toward redefining the conceptual framework within which we ask our questions, interpret our answers and formulate our management decisions. This is as true for scientific institutions as it is for political ones.

To that end, the intent of this chapter is to discuss the changing scientific framework in regard to salmon management; to explore some of the challenges of restoring salmon within an urban environment; to describe the proposed management framework and goals of the Tri-County comprehensive conservation and recovery strategies; and to explain the factors that produced the Tri-County as the conservation area.

Scientific Framework: The Emerging Salmon Management Paradigm

According to Mundy (1998) and others, the body of literature suggesting a change in the approach to salmon management is growing rapidly. This growth appears to stem from dissatisfaction among resource professionals with the outcome of past management programs for many exploited wild plant and animal species (Hofman and Powell 1998; Lauck, Clark et al. 1998).

In *Upstream: Salmon and Society in the Pacific Northwest,* the National Research Council (1996) stated that those involved in the process of salmon management need to be aware that a growing portion of the scientific community is deeply dissatisfied with the science of salmon fisheries management, as it has been practiced in the past. Increasingly, attempts are being made to move away from single-species management toward multi-species and ecosystem-based management strategies in wildlife management. Fisheries management has been slow to incorporate these concepts, much to the frustration of some scientists:

> *"An overriding focus on extraction of biomass and numerical goals in fishery management has promoted the depletion and biotic impoverishment of the Pacific salmon…resource. The prevalence of mechanistic thinking has marginalized or excluded critical ecological and cultural functions that sustain the resource and embody much of what humans value about it. This approach to salmon management has led to its own demise."* (NRC 1996, P.411. Frisell, Liss et al.)

In a fisheries context, the definition of conservation is changing from maxi-

mum sustainable yield toward "... the protection, maintenance and rehabilitation of native biota, their habitats, and life-support systems to ensure ecosystem sustainability and biodiversity" (Caddy 1995). This is echoed by Olver (1995), *Return to the River* (1996) and numerous others in various reviews of conservation principles for fisheries management. The numerous comments converge on two basic principles of conservation (Olver 1995):

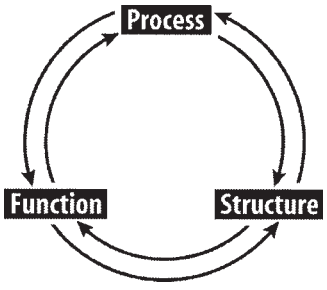
1. The sustainability of a fish stock requires protection of the specific physical and chemical habitats utilized by the individual members of the stock; and
2. The sustainability of a fish stock requires maintenance of its supporting native community.

Thus, conservation principles for sustainable fisheries (salmon) management appear to be converging on the generic purpose of maintaining (and restoring in some cases) ecosystem function, [structure] and processes (Starnes, Jiminez et al. 1995). This approach has been made explicit by the Alaska Department of Fish and Game's *Principles and Criteria for Sustainable Salmon Management* (Mundy 1998) where it has been coupled with a precautionary approach to harvest and habitat management.

The ecosystem approach has been further defined for Pacific salmon in National Marine Fisheries Service's own document, *Coastal Salmon Conservation: Working Guidance for Comprehensive Salmon Restoration Initiatives on the Pacific Coast* (NOAA 1996). In this working paper, NMFS refined and expanded the PACFISH ecological goals to provide more detail on the ecological structure and function needed for listed salmon. This restatement included a landscape ecology perspective and recognized the relationship among various spatial and temporal scales of ecosystems. The foundation for these goals was reviewed and further expanded in *An Ecosystem Approach to Salmonid Conservation* (Spence, Lomnicky et al. 1996), a joint publication of NMFS, EPA, and USFWS. In this document, the authors emphasize that an approach that recognizes ecological functions is critical to the success of salmon conservation. In fact, the work makes a fundamental assertion in its opening paragraphs: *"Aquatic habitats critical to salmonids are the product of processes acting throughout watersheds and particularly within riparian areas along streams and rivers ... salmonid conservation can be achieved only by maintaining and restoring these processes and their natural rates."* The authors state that if ecosystems are allowed to function in a natural manner, habitat characteristics favorable to salmonids will result.

Fundamentally, the ecosystem approach recognizes that the characteristics of watersheds – disturbance history, distribution and abundance of habitats, and species composition – vary over time from basin to basin, the result of interactions among process, structure and function (see Figure 1). Salmonids have become adapted to these patterns over many thousands of years, resulting in more or less local populations within watersheds. Thus, the maintenance and restoration of survival patterns depends upon the integrity of the ecosystem processes that underlie local diversity and abundance.

Figure 1



These goals – and the conservation principles discussed above – form the basis for King County's approach to salmon conservation within its borders. **In short, the County's approach is intended to be ecosystem-based, multi-species, and precautionary.**

Ecological Principles of Salmonid Conservation

The following principles of ecosystem and conservation ecology will guide our actions as we seek to protect and recover salmon in our rivers and streams.

- Maintain and restore natural watershed processes that create habitat characteristics favorable to salmonids;
- Maintain and restore habitats required by salmonids during all life stages;
- Maintain and restore functional corridors linking these habitats;
- Maintain a well-dispersed network of high quality refugia;
- Maintain connectivity among refugia;
- Protect the core areas first; and
- Employ adaptive management principles in all activities.

Problem of Restoration in the Urban Environment

Even if we employ the principles of ecosystem and conservation ecology, the urban area of Puget Sound presents an unusual challenge to the conservation and recovery of salmon.

Much of the native landscape has been irretrievably altered and will require considerable intervention and management if wild salmon populations are to survive and flourish. The once dynamic relationship among landscape structure, process and function (see Figure 1) has been so modified that restoration, as defined by the National Research Council (1992), may be impractical, if not impossible.

Still, some level of remediation is necessary even in those places where the urban landscape has eliminated the native one. In these places, the achievement of functional salmon habitat – even if some structural or process elements of the historic ecosystem cannot be restored – is necessary for salmon survival.

The life history characteristics of salmonids dictate that certain habitats and functions must be present at appropriate times and at appropriate locations within the salmon's environment. Without this functional relationship among location, timing and life history, the extinction of certain life history types, and possibly of the species itself, is assured. This task of restoration and remediation is perhaps the most difficult and contentious of salmon conservation and recovery. Once again, the NRC has provided some guidelines for restoration that will prove useful. In *The Restoration of Aquatic Ecosystems* (1992), the NRC suggests some standard definitions and a progressive approach to the repair of damaged systems.

Priorities for Restoration and Rehabilitation

King County has adopted the following priorities for restoration and rehabilitation:

1. Restore the natural flow and sediment regimes:
    - Daily, seasonal, annual, and longer patterns of floods and droughts.
    - Sediment size and distribution
2. Re-establish habitat connectivity along the river length:
    - Remove or modify artificial barriers to upstream and downstream movement of fishes, sediment, woody debris and nutrients.
    - Do not modify natural barriers.
3. Re-establish connectivity across the river environment:
    - Remove non-essential levees and revetments.
    - Remove flood-prone structures.
4. Restore natural channel geometry.
5. Restore the natural riparian community.
6. Enhance specific habitat attributes:
    - Add large woody debris.
    - Construct pool habitats.
    - Add spawning gravels.
7. Re-establish the native aquatic plant and animal community.

The Management Framework

The experiences of managers attempting to conserve salmon in the Columbia River system should be instructive in Puget Sound. For many years, a variety of remedial and restorative actions were undertaken on the Columbia with enthusiasm and sincerity but with little evaluation and less success. The frustration surrounding these apparent failures and the costs associated with them led to a wholesale re-evaluation of the management of the Columbia River fishery resources and the implementation of the first adaptive management program in the Northwest (Lee 1985).

Since that time, the activities undertaken to affect salmon management are treated as experiments with explicit objectives and predicted outcomes. Indicators of the outcomes are selected and assessment questions (hypotheses) developed. The information gathered during the assessment is used to modify the management activity and, if necessary, pose new management strategies.

Spence et al. (1996) discuss the adaptive management approach at length and suggest that it should be the framework for implementing and assess-

ing all management actions undertaken to conserve salmon. They define **adaptive management** as "*the periodic reappraisal of management goals and activities based on information gathered explicitly to test these goals and activities.*" This definition is in agreement with Lee and others who advocate a hypothesis-based approach to management of natural resources. Using an adaptive management framework, the monitoring strategy for salmon conservation has several elements:

1. Develop a set of explicit assessment questions for the activity.
2. Determine the ecological indicators.
3. Use the index concept in selecting sampling periods, sites and locations.
4. Develop a sampling design that is appropriate for answering the assessment questions.
5. Establish reference conditions (historical, literature-based or undisturbed) as standards.
6. Apply the data in answering management questions or in asking new ones.
7. Evaluate the effectiveness of the management strategy.
8. Identify ecosystem elements requiring additional research.

If this strategy is carefully and thoughtfully applied to all or most management actions, and so long as the action or activity is not a permanent change that cannot be altered, the risk of long-term, permanent harm to the resource is diminished considerably.

Management Goals

The goals of the management approach are simple. They are intended to apply in the order listed and to establish a firm foundation for both conservation and recovery. All actions in the package fit into one of the categories below.

1. **First, do no harm.**

   Reduce and prevent harm by abandoning, modifying or mitigating existing programs, projects and activities.

2. **Conservation**

   Protect key watersheds, landscapes, and habitats by acquisition, regulation or voluntary action.

3. **Remediation**

   Restore, rehabilitate and enhance damaged habitats to complement conservation actions.

4. **Research**

   Fill critical gaps in scientific and institutional information.

The actions proposed are intended to be those that can (and should) be undertaken immediately by local governments to preserve salmon and their

habitats. The approach is necessarily habitat-based; local governments possess authority in areas that directly affect the management of land and water resources, but do not touch on issues of harvest or propagation.

Through land use laws and ordinances that protect critical areas, regulate clearing and grading, and control stormwater discharges, King County (and other local governments) establishes the protective mechanisms for system function. Through requirements for stream and wetland mitigation and restoration, and using a variety of public education, incentive and acquisition programs, habitats can be protected directly and system function maintained. The use of this authority and of the various programs available to local governments forms the first, interim steps in the conservation of salmon while longer-term more comprehensive recovery plans get underway. These WRIA efforts are discussed in Chapter 7 of this report.

Determining the Conservation Area

The appropriate area for salmon conservation is of considerable interest to scientists and managers alike. National Marine Fisheries Service scientists have established the evolutionary scale of conservation at the level of Puget Sound. This Evolutionary Significant Unit (ESU) is the proper scale to ensure genetic diversity and evolutionary continuity among all related populations of Puget Sound Chinook. However, there are smaller (and larger) scales of conservation for other processes that must be accounted for as well. Provisions for habitat refugia, for example, must occur at scales from the ESU to local basins and sub-basins; the restoration of particular habitats and environments must occur at watershed scales within particular watersheds, and cannot be "transferred" to other areas. The choice of local conservation areas can be driven as much by management issues as by ecological ones, and often depends upon political processes as much as upon ecological ones.

Several factors have combined to produce the Tri-County conservation area:

- First, the area combines the most heavily populated regions in Puget Sound with those undergoing the most-rapid urbanization. This has produced an area with similar issues surrounding salmon habitat that are often quite different from other areas of Puget Sound.
- Second, the political leadership within the Tri-County has a record of cooperation on other issues such as water supply and transportation, all of which are useful models for this effort.
- Third, this area has considerable scientific, institutional and political expertise that can be called upon to address the salmon problems; and
- Fourth, the area makes at least some ecological sense insofar as the populations of salmon tend to be at least somewhat related. To be a bit more consistent with genetic and ecosystem properties, however, the area probably should be extended into south Puget Sound and across to Kitsap County to capture other populations and include critical nearshore and marine habitats.